

Fire Hazard Analysis

Building 1004A RF Support Building

Building 1004B Cryo/Main Power Supply Building

Brookhaven National Laboratory

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1.0 OVERVIEW AND RECOMMENDATIONS

1.1 Purpose and Methodology

A Fire Hazard Analysis (FHA) was performed for the Buildings 1004A and 1004B of the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL), Upton, NY. Building 1004A is the RF Support building. Building 1004B is the Cryo/Main Power Supply Service Building. This report fulfills the requirement for documentation of an FHA as outlined in DOE Order 420.1, Facility Safety. This FHA assesses the risk from fire in Building 1004 complex to ascertain whether the facility meets the objectives of DOE Order 420.1 and the Brookhaven National Laboratory (BNL) Fire Safety Program. The fundamental goal of the BNL Fire Safety Program is to control fire risks such that:

1. Public and employees are not unreasonably endangered by fire;
2. Vital Laboratory missions are maintained without significant interruption from fire;
3. Property losses are limited to less than \$1 million dollars per occurrence, and lower when justified by cost-effective, risk reduction measures;
4. Damage to the environment is averted; and
5. The potential for occurrences of fires are avoided whenever economically feasible.

This FHA is an evaluation of the fire hazards (1) that expose the 1004 complex and (2) that are inherent in the building or operations. The adequacy of the fire safety features in the building and the degree of compliance of the facility with specific fire safety provisions in DOE orders, and related engineering codes and standards, were determined. The results of the analyses are presented in terms of the fire hazards present, the potential extent of fire damage, and the impact on employee and public safety.

The general approach taken to complete this evaluation involved the identification of fire hazards in the building and the fire protection features required to mitigate the adverse consequences of a fire. A determination was made as to the adequacy of the proposed fire protection features to effectively control the fire hazards. Concerns for the protection of safety systems, critical processes, and life safety of building occupants from fire were essential considerations in the analysis. Compliance was determined by a comparison of existing conditions found during the site visits with current code requirements. Where conflicting requirements were found the more conservative requirements were used in this evaluation.

Maximum Possible Fire Loss (MPFL) and Maximum Credible Fire Loss (MCFL) potentials were also evaluated. The MPFL, as defined in DOE Order 420.1, is the value of property within a fire area, unless a fire hazard analysis demonstrates a lesser (or greater) loss potential, assuming the failure of both automatic fire suppression systems and manual fire fighting efforts. The MCFL, as defined in DOE Standard 1066-99 Fire Protection Criteria, is the value of property within a fire area, unless a fire hazard analysis demonstrates a lesser (or greater) loss potential. This assumes that all installed fire protection systems function as designed, and the effect of emergency response is omitted except for post-fire actions. Both MPFL and MCFL fire

loss estimates are to include the replacement cost of equipment and property and any applicable decontamination and cleanup costs.

The MPFL scenario was based on a qualitative consideration of several factors; the potential to reach flashover conditions based on combustible loading and the geometry of the space(s) under consideration; adequacy of passive protection features; and continuity of combustibles.

The MCFL scenario is one in which automatic suppression systems function as designed. Since properly designed and installed sprinkler systems should limit the fire growth and/or damage to the design area of the system, this floor area is used in the determination of MCFL potentials when protected by automatic sprinkler systems. Without sprinkler protection the MCFL is the same as the postulated MPFL for that area.

MPFL and MCFL potentials were determined based on an average dollar density of the building replacement value divided by the floor area of the building. Building values were obtained from 2004 replacement costs. The content and equipment value were calculated based on the following assumptions:

- An average of \$20/ft² for content and equipment value within predominantly office areas.
- An average of \$100/ft² for content and equipment value within the industrial and experimental areas of the building.

The above cost assumptions are considered adequately conservative to address the requirement to include decontamination and cleanup costs.

A qualitative assessment of the risk presented by conditions found to be deficient was also performed and is included in Section 8, Recommendations. This assessment was made by assignment of a risk assessment code (RAC). The RAC methodology is used in a number of industries as a tool to qualitatively prioritize deficiencies and corrective actions and is derived as follows:

1. Hazard Severity. An assessment of the worst potential consequence, defined by degree of occupational injury, illness or property damage which is likely to occur as a result of the deficiency. Hazard severity categories shall be assigned by roman numerals according to the following criteria:

- a. Category I. May cause death, permanent total disability, or loss of a facility/asset.
- b. Category II. May cause permanent partial disability, temporary total disability in excess of 90 days (severe injury or severe occupational illness), or major property damage.
- c. Category III. May cause minor injury, occupational illness, or property damage.
- d. Category IV. Presents minimal threat to personnel safety or health, or property, but is still in violation of a standard.

2. Mishap Probability. The probability that a hazard will result in a mishap or loss, based on an assessment of such factors as location, exposure (cycles or hours of operation), affected populations, experience, or previously established statistical information. Mishap probability shall be assigned an English alphabet symbol according to the following criteria:

a. Subcategory A. Likely to occur immediately or within a short period of time. Expected to occur frequently to an individual item or person or continuously to a fleet, inventory or group.

b. Subcategory B. Probably will occur in time. Expected to occur several times to an individual item or person or frequently to a fleet, inventory or group.

c. Subcategory C. May occur in time. Can reasonably be expected to occur some time to an individual item or person or several times to a fleet, inventory or group.

d. Subcategory D. Unlikely to occur.

3. Risk Assessment Code. Using the matrix shown below, the RAC is expressed as a single Arabic number that is used to help determine hazard abatement priorities.

Hazard Severity	Mishap Probability			
	A	B	C	D
I	1	1	2	3
II	1	2	3	4
III	2	3	4	5
IV	3	4	5	6

RAC Definitions

1-Critical

2-Serious

3-Moderate

4-Minor

5 & 6-Negligible

1.2 Summary

This Fire Hazards Analysis (FHA) has been performed to comprehensively assess the risk from fire in the 1004 complex. The FHA includes an analysis of the fire and life safety features of the facility to determine the level of compliance with DOE Order 420.1 Fire Protection objectives.

Based on the analysis, it has been determined that, with the exception of the lack of lightning protection, the Building 1004 complex does comply with DOE Order 420.1 Fire Protection objectives. The following recommendations are the result of this evaluation.

1.3 Findings and Recommendations

1.3.1 New Findings and Recommendations

Finding: Building 1004A is not protected by a lightning protection system.

Hazard Severity	I
Mishap Probability	C
Risk Assessment Code	2

Recommendation HAI-07-1004A-01: A NFPA 780 compliant lightning protection system should be provided for Building 1004A. (See Section 6.6.1)

Finding: Building 1004B is not protected by a lightning protection system.

Hazard Severity	I
Mishap Probability	C
Risk Assessment Code	2

Recommendation HAI-07-1004B-02: A NFPA 780 compliant lightning protection system should be provided for Building 1004B. (See Section 6.6.1)

The following is a summary of recommendations and their relative priority.

Rec.No.	Recommendation	RAC
HAI-07-1004A-01	Based on a risk analysis per NFPA 780, a lightning protection system should be considered for Building 1004A, (See Section 6.6.1).	2
HAI-07-1004B-02	Based on a risk analysis per NFPA 780, a lightning protection system should be considered for Building 1004B, (See Section 6.6.1).	2

1.3.2 Outstanding Recommendations from Previous Reviews

None

2.0 SCOPE

This FHA is based on information supplied by the Accelerator Department staff, a survey of the facility conducted during a site visit on December 11 – 16, 2006, and a review of available drawings.

The following codes and standards were utilized for this evaluation:

The Building Code of New York State 2002 Edition (BCNYS)

International Code Council (ICC), International Building Code (IBC) 2003 Edition;

ICC, International Fire Code (IFC) 2003 Edition;

National Fire Protection Association (NFPA) Codes, Standards, and Recommended Practices, including NFPA 101, Life Safety Code 2006 Edition (LSC) – See Section 9 (Reference Documents) of this report for a complete list.

Factory Mutual Property Loss Prevention Data Sheets – See Section 9 (Reference Documents) of this report for a complete list.

3.0 LOCATION

The 1004 complex is located along the southern portion (four o'clock) of the RHIC “ring” region of Brookhaven National Laboratory (BNL). BNL is a 5,000 acre site owned by the Department of Energy and operated by Brookhaven Science Associates. BNL is located in Upton, New York.

The 1004 complex consists of the following structures:

1. Building 1004A – RF Support Building
2. Building 1004B – Cryo/Main Power Supply Service Building

4.0 CONSTRUCTION

4.1 Occupancy Classification

The following occupancy classifications for Buildings 1004A and 1004B are based on LSC and BCNYS criteria:

Use	LSC Occupancy Classification	BCNYS Group Classification
Building 1004A		
Tech lab	Existing business	Group B
Mechanical and electrical equipment rooms	Industrial	Group F-1
Building 1004B		
Control Room	Existing business	Group B
Operation area (electrical equipment)	Industrial	Group F-1

Since credited fire resistance-rated separations are not provided between occupancies, the building is classified as a mixed occupancy consisting of business and industrial occupancies based on LSC criteria [§6.1.14.2.2]. The means of egress facilities, type of construction,

protection, and other safeguards must comply with the most restrictive fire and life safety requirements of the occupancies involved [§6.1.14.3.2].

4.2 Construction Type

Building 1004A

The exterior walls of Building 1004A consist of fiberglass-insulated metal panels with a total floor area of 6,270 sq ft. Interior walls are 8-in. concrete block. The floor is reinforced concrete. The construction types of this building are considered to be BCNYS Type IIB and NFPA Type II (000).

Building 1004B

Building 1004B is constructed from three prefabricated modular units, with a total floor area of 5,927 sq ft. The assembly is one story with a framed roof. Fiberglass insulation, metal studs, and metal framing were used throughout.

Life Safety Code

The LSC does not specify a minimum construction type for existing business and industrial [§39.1.6; §40.1.6] occupancies. Thus, the existing construction for each of the buildings complies with LSC requirements.

Building Code of New York State

Section 503 and Table 503 of the BCNYS contain criteria for the allowable height and area of buildings based on their occupancies and construction type.

Based on the limited sizes of Buildings 1004A (6,270 sq ft) and 1004B (5,927 sq ft), the buildings would comply with the construction type criteria for Type IIB structures as prescribed in Chapter 5 of the BCNYS.

4.3 Passive Fire Protection

Passive fire protection features include fire-resistive construction, fire doors, fire windows, and fire and smoke dampers. The features are provided to limit fire spread and damage from the area of fire origin to other portions of the building.

4.3.1 Fire Areas

The building is subdivided such that multiple fire areas are possible. A fire area is defined as a portion of a building that is bounded by a combination of fire-resistive walls and floor/ceiling assemblies, and/or exterior walls. In DOE facilities, fire areas are typically provided for property protection. The Implementation Guide for DOE Order 420.1 requires credited fire areas to be separated from the remainder of the building by a minimum of 2-hour fire barriers (walls and

horizontal assemblies). Fire areas may also be provided for compliance with building code limitations for building additions.

4.3.2 Fire Barrier Integrity

The majority of the dollar value for the facility is in the. However, a fire barrier or fire wall is not provided. This condition deviates from DOE's requirement to isolate high value equipment with fire resistance-rated construction.

5.0 FIRE PROTECTION

Existing fire protection systems that provide protection to full or segmented portions of this facility can be classified in four categories; Automatic Fire Suppression Systems, Fire Alarm, Automatic Detection Systems, and Fire Extinguishers. The following is a description of the existing installed systems in the building.

5.1 Automatic Fire Suppression Systems

5.1.1 Site Water Supply

BNL has a combination domestic and fire protection water supply system. The system is supplied by several deep wells and is stabilized by two elevated water storage tanks (one 1 million gallon and 300,000 gallon capacity). The wells have electric primary drivers and a limited number have backup internal combustion drivers. The system can sustain three days of domestic supply and a maximum fire demand (4,000 gallons per minute (GPM) for 4 hours) for BNL with two of the system's largest pumps out and one storage tank unavailable. The piping distribution network is well gridded. BNL has a combination domestic and fire protection water supply system. The system is supplied by several deep wells and is stabilized by two elevated water storage tanks (one 1 million gallon and 350,000 gallon capacity). The wells have electric primary drivers and a limited number have backup internal combustion drivers. The system can sustain three days of domestic supply and a maximum fire demand (4,000 gpm for 4 hours) for BNL with two of the system's largest pumps out and one storage tank unavailable. The piping distribution network is well gridded. Water supplies around the RHIC Ring Road are fed from two well separated connections to the BNL system. Ample valves provide isolation in case of a main break. Static water pressure to the 1004 complex is typically 70 psi. Water supplies to Buildings 1004A and 1004B are capable of supplying 1,700 gpm with 60 psi residual pressure.

Frost proof fire hydrants are provided within 300 ft of each facility. Frost proof hydrants are needed since the frost line extends to 4 feet below the surface in the winter. BNL and the local Suffolk County Fire Departments use National Standard Thread couplings.

BNL's Plant Engineering Division maintains the water supply system. BNL's Fire/Rescue Group conducts valve inspections on the distribution system to ensure reliability of firefighting water supplies.

5.1.2 Building Water Supply and Fire Department Connection

Each sprinkler system riser is provided with a Fire Department Connection (FDC). The FDCs are located on the east and south sides of the building. The nearest hydrant is less than 100 feet from the fire department connections as required by code. The two 2 ½ inch outlets on the FDCs conform to National Standard Thread couplings standard. The piping between the Fire Department Connections and the supply side of the Alarm Check Valve Assembly is 4 inch. The pipe connects to the discharge side of the Alarm Check Valves.

5.1.3 Sprinkler Systems

Automatic fire suppression in Building 1004A consists of a preaction sprinkler system. Installation of the sprinkler system complies with NFPA 13. The system protecting Building 1004A has been designed to provide a 0.15 gpm per sq ft density over 2,500 sq ft with 250 gpm for hose streams (NFPA 13 Standard). The AH system is supplied by the same riser station as the WAH. Automatic fire suppression in Building 1004B consists of a wet-pipe sprinkler system. Waterflow alarms are connected to the building fire alarm systems. Sprinkler valve supervision reports through the Site Fire Alarm System as supervisory devices.

5.1.4 Fire Standpipe Systems

Standpipe and 1½-in. hose connections are provided in Building 1004A only.

5.2 Fire Alarm Systems

The facility has a fire alarm system that is connected to the Site Fire Alarm system.

5.2.1 Building Fire Alarm System

Brookhaven National Laboratory provides central fire alarm station coverage by an Underwriter Laboratory listed multiplexed Site Fire Alarm System. DOE Order 420.1 requires all facilities to be provided with a means to notify and evacuate building occupants and a means to notify the site fire department. The fire alarm system is a Wormald System MultiZone 20 Fire Alarm Control Panel; installed in 1987 (Wormald is now known as Grinnell Fire System). The system complies with the requirements of NFPA 72 for a Style 7D System.

Based on the criteria specified in BCNYS §907.2.2, a manual fire alarm system is not required in any of the buildings. A fire alarm system, initiated by manual means, is required in accordance with the Life Safety Code (LSC), 2000 edition, Section 39.3.4.

5.2.2 Site Fire Alarm System

Brookhaven National Laboratory provides central fire alarm station coverage using a fault tolerant sever infrastructure based multiplexed Site Fire Alarm System. The system is an Andover Continuum; installed in 2005 (Andover is a part of Simplex Grinnell). The system complies with the requirements of NFPA 72 defined as a Style 6 Class “A” System.

Two mirrored servers are located in separate buildings. If the lead server fails the system automatically switches over to the working server. The Site Fire Alarm System operates on a fault tolerant high speed Ethernet infrastructure that utilizes network switches and fiber wiring between each of the major components.

The Site Fire Alarm System monitors fire alarm panels located throughout BNL by uses the existing site telephone cable plant. RS232 signals are sent via full duplex line drivers. Each fire alarm panel has two channels connected to the Site Fire Alarm System. The panels are divided into 9 communication “loops.” It is currently monitoring 9,700 points. Response time from alarm at the panel to alarm indication at the Central Station is less than 82 seconds, which is within the 90 seconds allowed by NFPA 72.

The main console is at the Firehouse, Bldg. 599. This station monitors all fire alarm signals, trouble and communication status alarms. A satellite station is provided at Safeguards and Security, Bldg. 50, and receives only the fire alarm signals. If the Firehouse does not acknowledge an alarm within 90 seconds, the satellite station at Bldg. 50 will receive an audible indication to handle the alarm. A second satellite station is provided at AGS Main Control Room, Bldg. 911, and receives only the fire alarm signals from the RHIC/AGS accelerator buildings. A team of Collider-Accelerator Control Room operators and Health Physics Support personnel respond during accelerator operating times.

5.3 Automatic Detection Systems

Based on the automatic sprinkler protection provided throughout Buildings 1004A and 1004B, automatic fire detection is not required by the LSC or BCNYS.

Smoke detectors are provided in the tech lab, power units room and pump room, and in a portion of the mechanical area in Building 1004A. A heat detector is provided in the toilet room in Building 1004A. Smoke detectors are also provided throughout Building 1004B.

5.4 Fire Extinguishers

Portable fire extinguishers are required in existing business occupancies [§39.3.5].

Halon 1211 fire extinguishers are provided in the power unit room. CO₂ agent fire extinguishers are provided in the remainder of Building 1004A and in the operation area in Building 1004B. A Class ABC, dry-chemical extinguisher is provided in the control room of Building 1004B. The location and placement of portable fire extinguishers is in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

6.0 FIRE HAZARDS

Fire hazard potentials are classified into four major categories; Building Materials, Special Occupancies, Exterior Hazard Exposure, and Natural Hazard Exposure. The following is an evaluation of the 1004 Complex for each category.

6.1 Special Occupancies

6.1.1 Vital and Important Records Storage

Vital records are those records which are essential to the mission of an important program and which, if lost, could not be reproduced or obtained elsewhere. Important records are those records possessing a high value to the mission of an important program but which, if lost, could be reproduced or reconstructed with difficulty or extra expense.

Based on the above definition there are no vital or important records stored in these buildings.

6.1.2 Trailers and Portable Structures

There are no trailers or portable structures associated with the 1004 Complex.

6.1.3 Electrical Substations

A transformer yard is located west of Building 1004A. The transformer yard and Building 1004A adjoin a generator yard. A packaged A/C unit, cooling tower, and pad-mounted transformer are located north of Building 1004A.

A transformer yard is located southwest of Building 1004B. The transformers and switch gear are arranged to meet the recommendations in Factory Mutual Loss Prevention Data Sheet 5-4 for fire protection. The transformers do not present an exposure hazard to the facility or each other.

6.1.4 Flammable Liquid and Gas Storage

Flammable liquid and gas storage issues were not identified.

6.2 Housekeeping in Vital Areas

Good housekeeping and control of combustibles was observed during this survey. The Collider-Accelerator department self-inspection program (Tier I) monitors routine experimental aspects. The BNL Plan Review Process screens conventional construction operations.

6.3 Building Materials

This facility is constructed of noncombustible materials.

6.4 Exterior Exposure Hazards

Any exterior structure, area or piece of equipment that is subject to harmful effects from, or can cause harmful effects to this facility is defined as an exterior exposure. Exterior exposures can be categorized as: elements outside of the facility, and as components of the facility.

The STAR Gas mixing operation and gas storage pads meet the National Fire Protection Association and Factory Mutual Loss Prevention Data sheets separation guidelines. They are not considered exposures of concerns to the main facility.

The electrical sub station to the north of Building 1004A for experimental power and the house power from the sub station to the west meet the Factory Mutual Loss Prevention Data Sheet on electrical transformer yard separation. The emergency generator is separated by a two hour fire wall from the house transformer yard. These are not exposures of concern to Building 1004.

6.4.1 Elements Outside of the Facility

The following is a summary of fire exposures to the 1004 Complex. All exposures are evaluated using FM Data Sheet 1-20 "Protection against Exterior Fire Exposure." These exposures do not present an undue hazard to the 1004 Complex.

6.4.1.1 North Exposures

Exposures to the North are minimal.

6.4.1.2 South Exposures

Exposures to the south are minimal.

6.4.1.3 East Exposures

Exposures to the east consist of two transformer yards and the gas cylinder farm.

The transformer yard adjacent to the electrical equipment room at the northeast corner of Building 1004A contains a dry-type transformer. This transformer is approximately 15 ft from the exterior wall.

6.4.1.4 West Exposures

Exposure from the west is posed by Building 1004A. However, Building 1004A is fully-sprinklered and thus does not pose significant fire hazard.

6.4.2 Components of the Facility

Exposures between components of the facility are minimal. Sprinkler protection and passive fire barriers are in place to provide separation between components of the facility.

6.5 Natural Phenomenon Hazard Exposure

Natural Hazards can be classified in five hazard categories: lightning, windstorm, wild fire, earthquake and flooding. The following is an evaluation for each category.

6.5.1 Lightning Potential

The lightning damage potential for Building 1004A and Building 1004B is a concern based on NFPA 780 Annex L “Lightning Risk Assessment” calculation. Following the Risk Assessment methodology the expected lightning frequency (Nd) of 0.0074 is greater than the tolerable lightning frequency (Nc) of 0.0002 (calculations shown in Appendix B of this report). NFPA 780 recommends that a lightning protection system be installed when the expected frequency is greater than the tolerable frequency (See **Recommendation HAI-07-1004A-01 and Recommendation HAI-07-1004B-02**).

6.5.2 Windstorm Potential

The Long Island area basic wind speed (3-second gust) is 120 MPH based on Factory Mutual Data Sheet 1-28 and BCNYS figure 1609.4. The ground roughness exposure category for the Building 1004A and Building 1004B area is ‘Exposure B.’ Based on the calculations this building should have roof assemblies classified as “Class 90” rated assemblies. The roofs appear to be in good condition.

6.5.3 Brush Fire Potential

An analysis was completed consistent with the requirements and guidelines of NFPA 1144 *Protection of Life and Property from Wildfire* (2002) to determine the wildfire risk to Building 1004A and Building 1004B. The risk assessment was conducted in accordance with the Wildfire Hazard Severity Form checklist of NFPA 1144. The checklist is a summary of typical desirable characteristics found in various wildfire hazards analyses. Elements include emergency response ingress and egress, type of vegetation, topography, building construction and roofing materials, available fire protection, and utilities.

Based on the analysis, the hazard from wildfire to Building 1004A and Building 1004B is “LOW.” Specifics of the Wildfire Hazard Severity Analysis are shown in Appendix C of this report.

6.5.4 Earthquake Potential

The seismic damage potential for this facility is classified as low based on a Natural Hazards analysis produced for the BNL campus titled “DOE Accelerator Order 5480.25 Implementation Plane for Brookhaven National Laboratory National Phenomena Hazards Evaluation” dated April 1994. A low seismic classification means that the buildings and fire protection systems are not required to comply with seismic design standards.

6.5.5 Flooding Potential

Flood potential from bodies of water overflowing their normal levees is low for the BNL area. The flooding potential for this facility was classified as low in a Natural Hazards Analysis report produced for the BNL site, dated April 1994, titled “DOE Accelerator Order 5480.25 Implementation Plane for Brookhaven National Laboratory National Phenomena Hazards Evaluation.”

Ground water runoff from a severe rainstorm is not a concern for Building 1004A and Building 1004B due to the surrounding terrain.

6.6 Toxic Fire Potential

There are no known toxic materials present in the building that present a release potential due to fire.

6.7 Biological Fire Potential

There are no known biological materials present in the building that present a release potential due to fire.

6.8 Radiation Fire Potential

By the nature of the operations of the accelerator, various pieces of equipment can be expected to become activated. This activation is not expected to pose a significant environmental impact in the event of a fire since the material will not be easily disbursed.

For calibration of instruments, several small sealed calibration sources will be present. These sources do not have the curie content nor the physical state to be disbursed and contaminate large areas.

No other radioactive materials are used or stored in the 1004 Complex.

7.0 PRE-FIRE AND EMERGENCY PLANNING

The BNL Fire Department maintains an adequate pre-fire plan book for this facility (http://intranet.bnl.gov/emergencyservices/runcards/main_i.asp). The pre-plan was reviewed as part of this analysis.

7.1 Protection of Essential Safety Class Systems

There are no essential safety class systems associated with this non-nuclear facility.

7.2 Protection of Vital Programs

The operations associated with this facility are not considered to be a DOE vital program. Therefore, no special fire protection precautions, beyond those that are generically described in this report, are required for this facility.

7.3 Protection of High Value Property

High value equipment is generally regarded as any single item that is valued at \$1 million or more, or where the loss of a single item could result in a loss of program continuity of greater than six months.

7.4 Critical Process Equipment

Building 1004A is the RF Support building and Building 1004B is the Cryo/Main Power Supply Service Building for the Relativistic Heavy Ion Collider (RHIC).

The buildings contain power, control and monitoring equipment as well as pumps associated with RHIC Operations. The majority of components in these systems are common and easily deliverable. Custom parts in other sub systems do have limited spares.

7.5 Maximum Possible Fire Loss (MPFL) and Maximum Credible Fire Loss (MCFL)

The MPFL, as defined in DOE Order 420.1, is the value of property within a fire area, unless a fire hazard analysis demonstrates a lesser (or greater) loss potential, assuming the failure of both automatic fire suppression systems and manual fire fighting efforts. The fire loss estimate includes the replacement cost of equipment and property and any applicable decontamination and cleanup costs.

In accordance with the BNL Fire Safety Program, protection is required for facilities having an MPFL in excess of established thresholds as follows:

- When the MPFL exceeds \$1 million an automatic sprinkler system designed in accordance with applicable NFPA standards is required;
- When the MPFL exceeds \$25 million, a redundant fire protection system is required such that, despite the failure of the primary fire protection system, the loss will be limited to \$25 million; and
- When the MPFL exceeds \$50 million, a redundant fire protection system and a 3-hour fire resistance rated barrier are required to limit the MPFL to \$50 million.

7.5.1 MPFL Scenario

A single MPFL scenario is considered for each building; Building 1004A and Building 1004B. The following fire area tabulations were utilized when determining the MPFL and MCFL loss potentials.

Fire Area	Building Area (ft ²)
Building 1004A	6270
Building 1004B	5927

The buildings are each considered one fire area and thus a single MPFL calculation is being performed for each. The areas contain the support (control, monitoring, and power) equipment for the RHIC. The amount and continuity of combustible material is relatively low.

Combustible loading in the control areas of the buildings could conservatively be compared to an office fire that could potentially reach flashover conditions for heat release rates and fire duration. Flashover indicates that the temperature inside the area would be sufficiently hot to cause multiple fuel package ignitions within the space and result in loss of all contents. Associated compartment temperatures at flashover are generally accepted to be between 500°C (900°F) to 600°C (1100°F). Flashover is generally defined as the transition from a growing fire to a fully developed fire. Fully developed fires impose extensive thermal and physical stresses on fire barriers, the failure of which could lead to fire spread throughout the area. This comparison is conservative since the areas where the combustibles are located within the building represent a relative large volume, making flashover unlikely, but possible, especially if there would be transient combustibles in any particular area (which would be a failure of the combustible loading program).

7.5.2 MPFL Calculation

Building 1004A has a replacement value of approximately \$1 million. The building value was obtained from 2004 replacement costs. The average dollar density of the building is the replacement value divided by the floor area of the building ($\$1,000,000/6,270 \text{ ft}^2 = \$159/\text{ft}^2$ (\$160/ft²)).

Building 1004B has a replacement value of approximately \$900,000. The building value was obtained from 2004 replacement costs. The average dollar density of the building is the replacement value divided by the floor area of the building ($\$900,000/5,927 \text{ ft}^2 = \$152/\text{ft}^2$ (\$160/ft²)).

The content and equipment value is calculated based on the following assumptions:

- An average of \$20/ft² for content and equipment value within predominantly office areas.
- An average of \$100/ft² for content and equipment value within the industrial and experimental areas of the building.

MPFL Summary

	Building 1004A	Building 1004B
Building Value*	\$1,000,000	\$900,000
Contents*	\$6,270,000	\$5,927,000
MPFL Total	\$7,270,000.00	\$6,827,000.00

7.5.3 MCFL Scenario

The MCFL, as defined in DOE Standard 1066-99 Fire Protection Criteria, is the value of property within a fire area, unless a fire hazard analysis demonstrates a lesser (or greater) loss potential. This assumes that all installed fire protection systems function as designed, and the effect of emergency response is omitted except for post-fire actions.

The maximum credible fire scenario is one in which automatic suppression systems function as designed. The sprinkler design criterion for these buildings is based on a design area of 2,500 sq ft. Since properly designed and installed sprinkler systems should limit the fire growth and/or damage to the design area this floor area was used in the determination of MCFL potentials when protected by automatic sprinkler systems.

MCFL Summary

	Building 1004A	Building 1004B
Building Value*	\$397,500	\$380,000
Contents*	\$250,000	\$250,000
MPFL Total	\$647,500.00	\$630,000.00

7.5.4 MPFL/MCFL Summary

Fire Area	MPFL	MCFL
Building 1004A	\$7,270,000	\$6,827,000
Building 1004B	\$647,500	\$630,000

Based on the MPFL loss potentials automatic sprinkler protection is required throughout the building.

7.6 Recovery Potential

Critical process parts have been identified by the Department. Critical process parts are those items essential to the operations of the booster that require a long lead-time for replacement. Recovery potential is based on the ability to produce and replace electronic equipment and the various power supplies.

7.7 BNL Fire/Rescue Group

The BNL Fire/Rescue Group is a full time, paid department. Minimum staffing is five firefighters and one officer per shift. The firefighters are trained to meet Firefighter Level III by International Fire Service Training Association standard, National Fire Protection Association (NFPA) Fire Fighter Level II standard, and (NFPA) Hazardous Material Technician Level and they are Suffolk County Certified Confined Space Rescuers.

The BNL Fire/Rescue Group also provides emergency medical services to an on-site population of 3200 people. Minimums of two members per shift hold New York State "Emergency Medical Technician - D" certifications ("D" is for defibrillation). Normally all five firefighters have EMT status. The Group operates a New York State Certified Basic Life Support ambulance. Medivac services are available to BNL via the Suffolk County Police Department. Additionally the Fire/Rescue Group has two 1500 GPM "Class A" Pumps, one Rescue Vehicle for initial hazardous material incident response and heavy rescue operation, and one Incident Command Vehicle.

The single Fire Station is located on the west side of the BNL Site. Response time to the most remote section of the BNL Site is less than eight minutes. Response time to Building 1004 is estimated at 5 minutes.

BNL participates in the Suffolk County Mutual Aid Agreement. This allows the resources from over 130 departments to assist BNL. BNL is also a member of the Town of Brookhaven Foam Bank. BNL has a mutual aid agreement for hazardous material incidents with the Town of Brookhaven and Stonybrook University.

7.8 Fire Apparatus Accessibility

Fire apparatus accessibility is adequate for the facility. Current parking lot configurations allow access by apparatus in the event of an emergency.

7.9 Security Considerations Related to Fire Protection

There are no security considerations which relate to fire protection at this facility.

8.0 LIFE SAFETY CONSIDERATIONS

Life safety considerations for this facility include means of egress consisting of exit access, exits and exit discharge, exit signage, and emergency lighting. This building is required to comply with state building codes and NFPA 101, the *Life Safety Code* (LSC). The requirements of both the 2002 edition of the Building Code of New York State (BCNYS) and the 2006 edition of the LSC have been applied to this analysis. It should be noted that the BCNYS is not intended to apply to existing structures. Appendix K of the BCNYS addresses alterations to existing structures.

8.1 Occupancy Load Factor and Calculations

The occupant load per floor level for code purposes is calculated in Table 8.1-1 based on applicable occupant load factors specified in LSC Table 7.3.1.2. Factors for these spaces are not specified in the LSC. The control room in Building 1004B and the tech room in Building 1004A are the only normally occupied spaces and the occupant load of each space would not exceed 10 persons.

8.2 Means of Egress

8.2.1 Number and Arrangement of Exits

The LSC requires that a floor with an occupant load of 500 or fewer persons must have a minimum of two means of egress [§7.4.1.1]. Additional exits may be required for compliance with exit capacity or arrangement of exits criteria.

Building 1004A

Building 1004A is provided with multiple exits directly to grade. Exit doorways are located from the L-shaped mechanical equipment area, the tech lab, pump room and power units floor (two exits).

Building 1004B

Building 1004B is provided with three exits directly to grade, two of which are accessed from the operation area, and one of which is accessed from the control room.

The buildings comply with the code requirements for number of exits.

8.2.2 Capacity of Exits

The egress capacity provided from a floor or portion thereof must be sufficient to accommodate the occupant load. The egress capacity for an egress component is based on the width of the component. For stairways, the factor of 0.3 in. of stair width per person is applied. For doors, ramps, corridors, and other level components, the factor of 0.2 in. of width per person is applied.

Based on the limited occupancy of the buildings and the egress widths of exit doors, the egress capacity provided is adequate for the buildings.

8.2.3 Travel Distance

The exit access travel distance is the distance from an occupiable point to the nearest exit or exit enclosure. The maximum exit access travel distances for the occupancies involved are provided in Table 3.2.3 [LSC §39.2.6; §40.2.6].

Occupancy	Maximum Allowable Exit Access Travel Distance (ft) (sprinklered)
Business (sprinklered)	300
Special-Purpose Industrial	400

Where open stairways serve as means of egress, the travel distance must include the travel on the stairway and the distance to reach an outside door or other exit [§7.6.2].

The building is in general compliance with exit access travel distance limitations.

8.2.4 Common Path of Travel

The maximum allowable common path of travel for business and special purpose industrial occupancies is 100 ft (sprinklered)/75 ft (nonsprinklered) and 100 ft respectively. The common path of travel from mechanical equipment rooms, boiler rooms, and similar spaces is permitted to be not more than 100 ft [LSC §7.12.1(1) (c)].

The buildings comply with the common path of travel limitations.

8.2.5 Dead Ends

Dead-end corridors must not exceed 50 ft in industrial and business occupancies [LSC §39.2.5.2; Table 40.2.5]. The BCNYS limits dead-end corridors to not more than 50 ft in fully-sprinklered Group B or Group F occupancies [§1004.3.2.3, Ex. 2]. No dead-end corridors exceeding these limitations were identified.

8.2.6 Security Considerations Related to Fire Protection

There are no security considerations which relate to fire protection at this facility. Radiation Security barriers comply with the Life Safety Code for egress.

8.2.7 Separation of Means of Egress

Where two exits or exit access doors are required, they must be located at a distance from one another not less than one-third the length of the maximum overall diagonal dimension of the building or area served in fully-sprinklered buildings, and not less than one-half the length of the maximum overall diagonal dimension of the building or area served in other buildings [LSC §7.5.1.3.2; BCNYS §1004.2.2.1, Ex. 2]. The buildings comply with the separation of means of egress criteria as required by the BCNYS and LSC in all areas.

8.3 Exit Signs and Emergency Lighting

Exit signage is required in accordance with Section 7.10 of the LSC. Exit signs should be placed in corridors and in rooms required to have at least two means of egress. Internally-illuminated exit signs and exit placards are provided in the building.

Emergency lighting for means of egress is required in accordance with Section 7.9 of the LSC. Emergency lighting is required in a building classified as a business occupancy where the business occupancy is subject to 100 or more occupants above the level of exit discharge, the building is two or more stories in height above the level of exit discharge, or the business occupancy is subject to 1,000 or more total occupants [§39.2.9.1]. Emergency lighting is required in industrial occupancies [§40.2.9.1] except special-purpose industrial occupancies without routine human habitation. Emergency lighting is provided throughout the buildings. Ceiling light fixtures connected to the emergency generator are provided in the power units floor of Building 1004A. Emergency light modules equipped with battery packs are provided elsewhere.

8.4 Egress through Adjoining/Intervening Spaces

Exit access from rooms or spaces is permitted to be through adjoining or intervening rooms or areas, provided that such rooms or areas are accessory to the area served and the intervening rooms or areas are not spaces identified under Protection from Hazards (e.g., storage rooms) [LSC §7.5.1.6]. In general, the building complies with this requirement. Intervening rooms through which required egress occurs are accessory and not high hazard.

8.5 Exit Discharge

Exits are required to terminate directly at a public way or at an exterior exit discharge. Exits provided from the buildings discharge to the exterior of the buildings as required.

8.6 Fire Protection Systems Required by Code

Automatic sprinkler protection is required to address some of the conditions found in the building. These are discussed elsewhere in this report.

8.7 Operational Requirements that are Required by Code

There are no other fire protection related operational requirements required by code.

9.0 REFERENCE DOCUMENTS

9.1 National Fire Protection Association

NFPA 10, *Standard for Portable Fire Extinguishers*, 2002 Edition

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2002 Edition

NFPA 30, *Flammable and Combustible Liquids Code*, 2003 Edition

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, 2004 Edition

NFPA 51B, *Standard for Fire Prevention during Welding, Cutting, and Other Hot Work*, 2003 Edition

NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*, 2005 Edition

NFPA 70, *National Electrical Code*[®], 2005 Edition

NFPA 72[®], *National Fire Alarm Code*[®], 2002 Edition

NFPA 80, *Standard for Fire Doors and Fire Windows*, 1999 Edition

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2002 Edition

NFPA 101[®], *Life Safety Code*[®], 2006 Edition

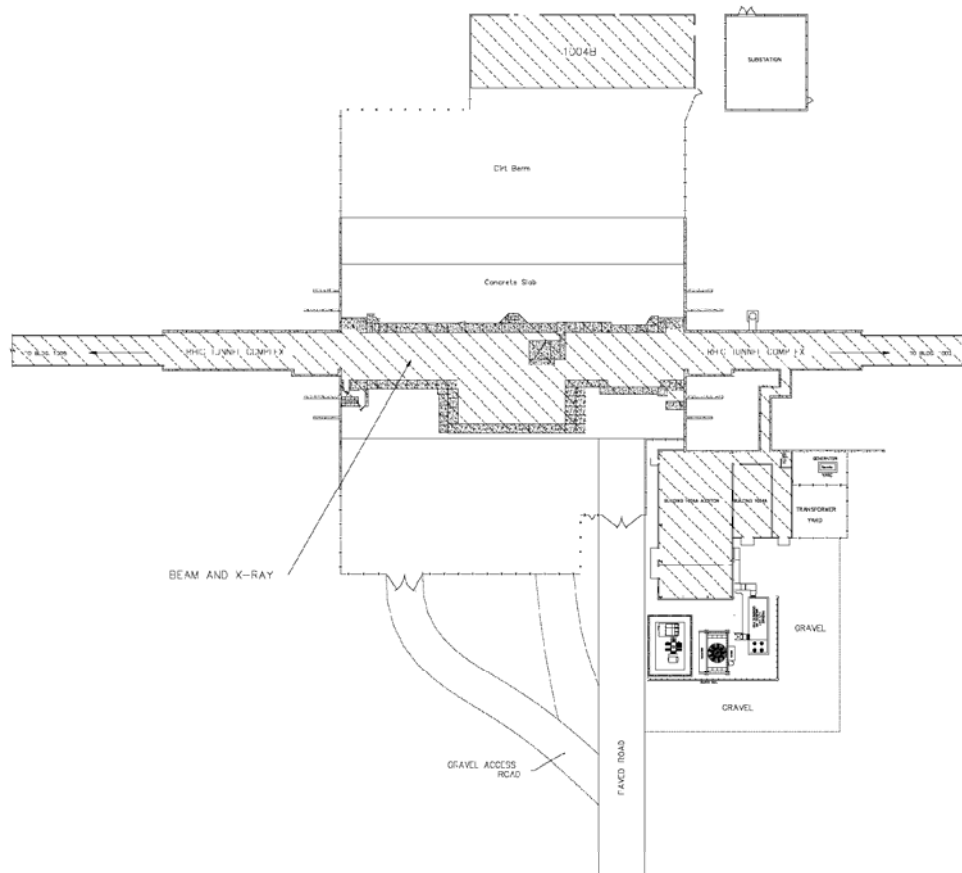
NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2004 Edition

NFPA 1144, *Standard for Protection of Life and Property from Wildfire*, 2002 Edition

9.2 FM Global Loss Prevention Data Sheets

5-4, Transformers

**APPENDIX A –
FHA FIGURES**



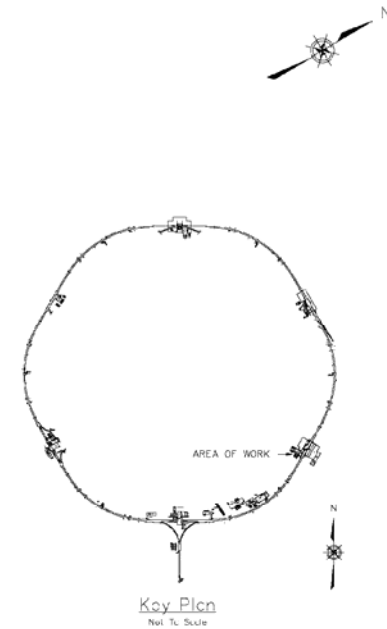
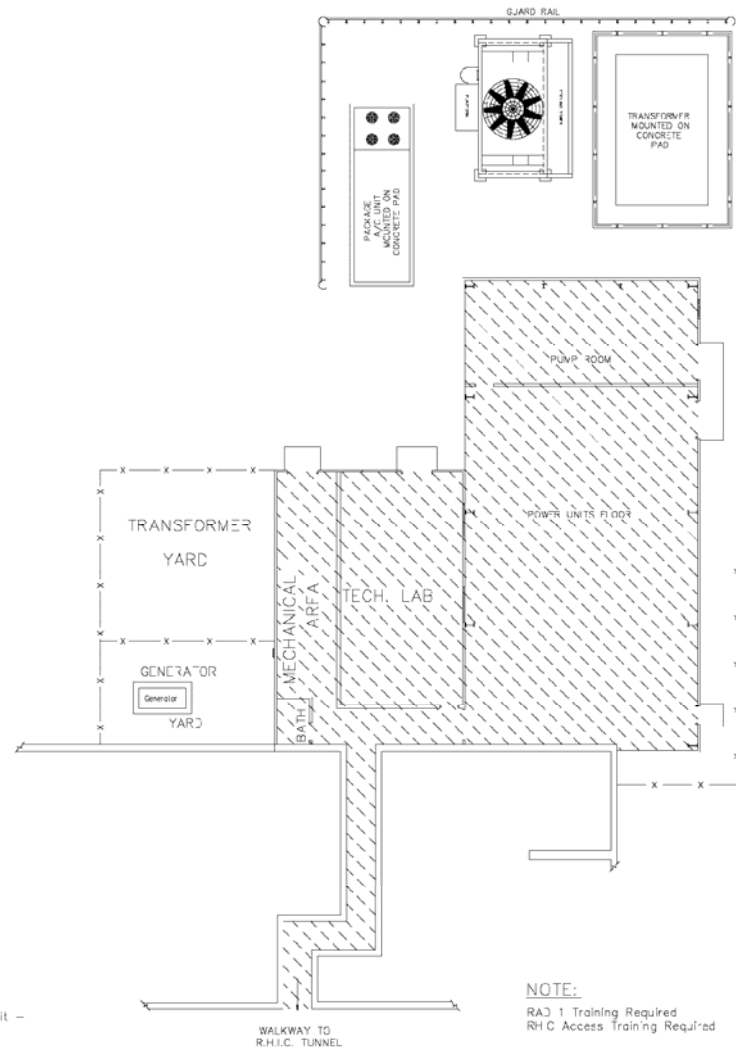
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"Crosshatched area may or may not need a work permit - contact the area Work Control Coordinator."

NOTE:

RAD 1 Training Required
RHIC Access Training Required

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<p>UNDER CONTRACT WITH UNITED STATES DEPARTMENT OF ENERGY PLANT ENGINEERING DIVISION UPTON, NEW YORK 11973</p>													
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<p>JOB NO. ST1004 1004</p>													



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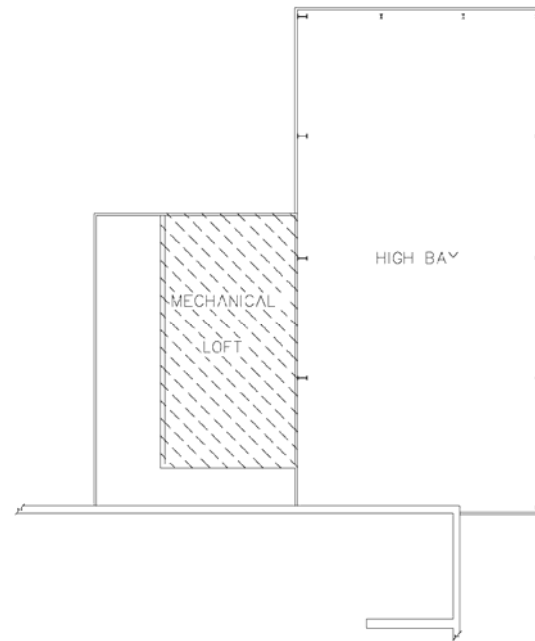
UNDER CONTRACT WITH

UNITED STATES DEPARTMENT OF ENERGY


PLANT ENGINEERING DIVISION

UPTON NEW YORK 11973

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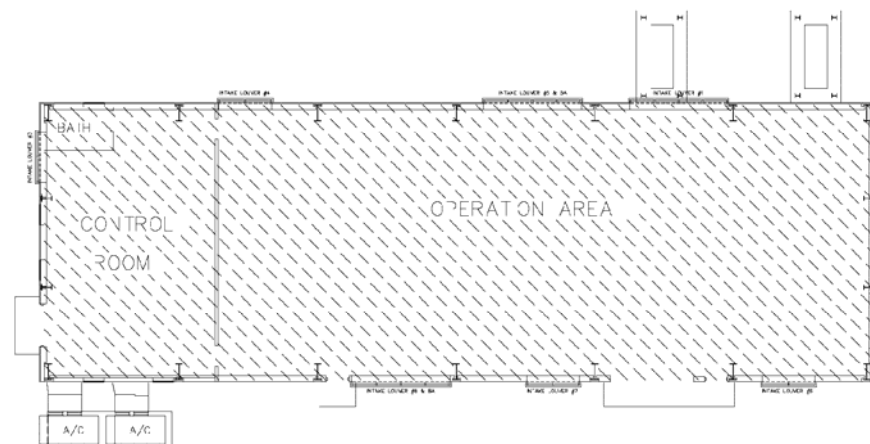
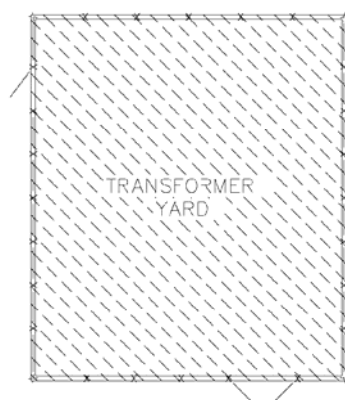
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NOTE:

RAD 1 Training Required



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		RF Support Building	
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PLANT	M.D.	05/04	
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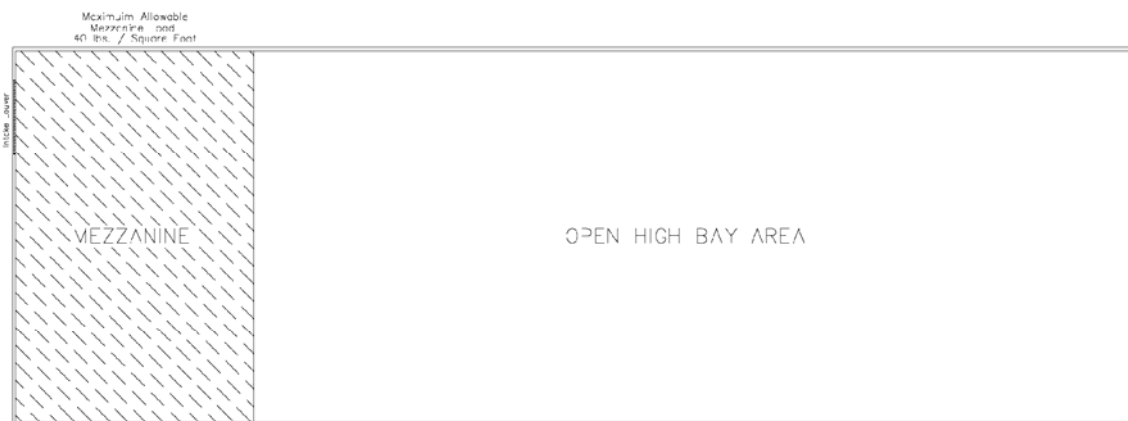
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NOTE:

RAD 1 Training Required

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JOB TITLE		SHEET TITLE	
Key Plans		4 O'clock Cryo / Main Power Supply Service Building	
PROJECT ON	JOURNAL DRAWING BY	DESIGNED BY	CHECKED BY
	M.P.	G.R.H.	
DRAWING SCALE	ORIGINAL DATE DRAWN	DATE REVISION	DATE REVISION
N.T.S.	04/27/94	05/04/98	
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MAINTENANCE MANAGEMENT CENTER		1004B	
68 BELLEVUE		SHEET NO.	
BUILDING 67		1004B-1	



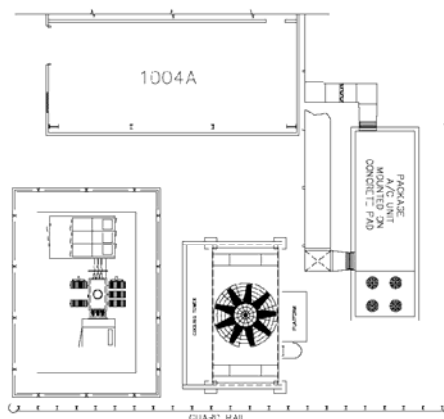
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NOTE:

RAD 1 TRAINING REQUIRED

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LEGEND:

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NOTE:

RAD 1 TRAINING REQUIRED
RHIC ACCESS TRAINING REQUIRED

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511004C		1CC4C	

APPENDIX B –
LIGHTNING RISK CALCULATION

The expected lightning frequency (Nd) is **0.0074** and the tolerable lightning frequency (Nc) is **0.0002**. Based on NFPA 780, If $N_d > N_c$, a lightning protection system should be installed.

TOLERABLE LIGHTNING FREQUENCY FROM NFPA 780 APPENDIX L

$$N_c = \frac{1.5 \times 10^{-3}}{C}$$

where $C = (C_2)(C_3)(C_4)(C_5)$.

$$N_c = 0.0002$$

Assume

1.0

C_2 — Structural Coefficients			
Roof			
Structure	Metal	Nonmetallic	Flammable
Metal	0.5	1.0	2.0
Nonmetallic	1.0	1.0	2.5
Flammable	2.0	2.5	3.0

Assume

2.0

Structure Contents	C_3
Low value and nonflammable	0.5
Standard value and nonflammable	1.0
High value, moderate flammability	2.0
Exceptional value, flammable, computer or electronics	3.0
Exceptional value, irreplaceable cultural items	4.0

Assume

1.0

Structure Occupancy	C_4
Unoccupied	0.5
Normally Occupied	1.0
Difficult to evacuate or risk of panic	3.0

Assume

5.0

Lightning Consequence	C_5
Continuity of facility services not required, no environmental impact	1.0
Continuity of facility services required, no environmental impact	5.0
Consequences to the environment	10.0

 = input required

APPENDIX C –
DETERMINATION OF WILDFIRE
HAZARD SEVERITY USING NFPA 1144

ELEMENT	POINTS
A. Means of Access	
1. Ingress and egress <ul style="list-style-type: none"> a. Two or more roads in/out b. One road in/out 	0√ 7
2. Road width <ul style="list-style-type: none"> a. ≥ 24 ft b. ≥ 20 ft and < 24 ft c. < 20 ft 	0 2√ 4
3. All-season road condition <ul style="list-style-type: none"> a. Surfaced road, grade < 5% b. Surfaced road, grade > 5% c. Non-surface road, grade < 5% d. Non-surface road, grade > 5% e. Other than all-season 	0√ 2 2 5 7
4. Fire Service Access <ul style="list-style-type: none"> a. ≤ 300 ft with turnaround b. > 300 ft with turnaround c. < 300 ft with no turnaround d. ≥ 300 ft with no turnaround 	0√ 2 4 5
5. Street Signs <ul style="list-style-type: none"> a. Present b. Not present 	0√ 5
B. Vegetation (Fuel Models)	
1. Characteristics of predominate vegetation within 300 ft. <ul style="list-style-type: none"> a. Light (e.g., grasses, forbs, sawgrassess, and tundra) NFDRS Fuel Models A,C,L,N,S, and T b. Medium (e.g. light brush and small trees) NFDRS Fuel Models D,E,F,H,P,Q, and U c. Heavy (e.g. dense brush, timber, and hardwoods) NFDRS Fuel Models B,G, and O d. Slash (e.g. timber harvesting residue) NFDRS Fuel Models J,K, and L 	5 10√ 20 25
2. Defensible space <ul style="list-style-type: none"> a. More than 100 ft of vegetation treatment from the structures b. 71 ft to 100 ft of vegetation treatment from the structures c. 30 ft to 70 ft of vegetation treatment from the structures d. < 30 ft of vegetation treatment from the structures 	1 10√ 25
C. Topography Within 300 of Structures	
1. Slope < 9%	1√
2. Slope 10% to 20 %	4
3. Slope 21% to 30%	7

- | | | |
|----|------------------|----|
| 4. | Slope 31% to 40% | 8 |
| 5. | Slope > 41% | 10 |

D. Additional Rating Factors

- | | | |
|----|---|----------|
| 1. | Topographical features that adversely affect wildland fire behavior | 0-5 [0√] |
| 2. | Areas with a history of higher fire occurrence than surrounding areas due to special situations | 0-5 [0√] |
| 3. | Areas that are periodically exposed to unusually severe fire weather and strong dry winds. | 0-5 [0√] |
| 4. | Separation of adjacent structures that can contribute to fire spread | 0-5 [0√] |

E. Roofing Assembly

- | | | |
|----|--------------|----|
| 1. | Class A roof | 0 |
| 2. | Class B roof | 3√ |
| 3. | Class C roof | 15 |
| 4. | Nonrated | 25 |

F. Building Construction

- | | | |
|----|---|----|
| 1. | Materials | |
| a. | Noncombustible/fire-resistive siding, eaves, and deck | 0√ |
| b. | Noncombustible/fire-resistive siding and combustible deck | 5 |
| c. | Combustible siding and deck | 10 |
| 2. | Building setback relative to slopes of 30% or more | |
| a. | >= 30 ft to slope | 1 |
| b. | < 30 ft to slope | 5 |

G. Available Fire Protection

- | | | |
|-----------------------------------|--|----|
| 1. | Water source availability | |
| a. | Pressurized water source availability | |
| 500 gpm hydrants <= 1000ft apart | | 0√ |
| 250 gpm hydrants <= 1000ft apart | | 1 |
| b. | Nonpressurized water source availability | |
| >= 250 gpm continuous for 2 hours | | 3 |
| < 250 gpm continuous for 2 hours | | 5 |
| c. | Water unavailable | 10 |
| 2. | Organized response resources | |
| a. | Station <= 5 miles from structure | 1√ |
| b. | Station > 5 miles from structure | 3 |
| 3. | Fixed fire protection | |
| a. | NFPA 13 | 0√ |
| b. | None | 5 |

H. Placement of Gas and Electric Utilities

- | | |
|-------------------------------------|----|
| 1. Both underground | 0√ |
| 2. One underground, one aboveground | 3 |
| 3. Both aboveground | 5 |

I. Total

18

Hazard Assessment	Total Points
Low hazard	< 40
Moderate hazard	40-69
High hazard	70-112
Extreme hazard	> 112

A Wildfire Severity Level of 32 = A LOW Hazard